

NASA TECH BRIEF

NASA Pasadena Office

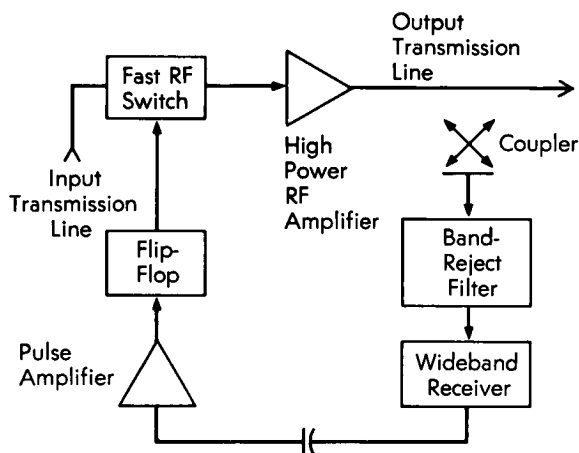


NASA Tech Briefs announce new technology derived from the U.S. space program. They are issued to encourage commercial application. Tech Briefs are available on a subscription basis from the National Technical Information Service, Springfield, Virginia 22151. Requests for individual copies or questions relating to the Tech Brief program may be directed to the Technology Utilization Office, NASA, Code KT, Washington, D.C. 20546.

Arc Protection System for High-Power RF Amplifiers

The problem:

To prevent damage or destruction of a high-power RF amplifier by arcs which may occur in the output transmission line. The available systems which use light or reflected RF wave energy to trigger protection circuits are too complex and do not afford reliable arc protection for the output windows of Klystrons, traveling-wave tubes, and the like.



The solution:

Trigger a protective system by the RF noise burst that accompanies an arc.

How it's done:

An RF arc anywhere in the output transmission line causes a burst of RF noise that propagates away from the arc in both directions. The noise burst is coupled out of the transmission line by a loose, non-directive coupler through a band-reject filter. This filter is required to prevent the wideband receiver

and the pulse amplifier indicated in the figure from responding to normal signal modulation. The energy passed by the band-reject filter is detected by the wideband receiver, and the detected envelope of the arc-generated RF burst is amplified by the pulse amplifier. The output of the pulse amplifier triggers a flip-flop which provides a bias signal that turns off a fast RF switch in the input line to the high-power RF amplifier. Because the fast-acting RF switch controls the drive energy from the input transmission line to the power amplifier, the arc in the output transmission line will be extinguished when the output RF power level falls in response to drive cutoff.

The response time of the system (from the start of an arc to its extinction due to drive cutoff) is the sum of the following delays: 1) propagation time of RF noise from arc location to coupler, 2) the response time of the wideband receiver, 3) the response time of the pulse amplifier and flip-flop, 4) the response time of the fast RF switch, 5) propagation time of an RF step through the tube, 6) propagation time of RF step from tube output to location of the arc. With careful design, the sum of these delays (exclusive of the propagation times of the output transmission line) can be held to less than 150 nanoseconds. The maximum propagation times for a transmission line cannot be predetermined precisely, for they are established by the length of the particular transmission line.

Specific advantages of the system over prior designs based on detection of light from the arc or the reflection of RF waves are:

1. The entire transmission line can be monitored from a single noise burst detection port (the loose, nondirective coupler) regardless of line length or

(continued overleaf)

shape. In contrast, systems using photodetection can only react when an arc occurs within line of sight. Systems using reflected RF waves cannot detect arcs unless they occur further from the source (amplifier tube) than the directional coupler; an arc at or near the tube window will not be detected.

2. The frequency spectrum of the RF noise is very wide. Therefore, signal loss in the band-reject filter is small.
3. The risetime of the wideband RF receiver is much shorter than that of any type of photodetector in general use.
4. The normal level of out-of-band noise in the transmission line is very much lower than that which would be produced by an arc. Sensitivity adjustment and maintenance of the described system are, therefore, not as critical as with systems using reflected RF waves for arc detection.

Note:

Requests for further information may be directed to:

Technology Utilization Officer
NASA Pasadena Office
4800 Oak Grove Drive
Pasadena, California 91103
Reference: B72-10099

Patent status:

No patent action is contemplated by NASA.

Source: Ralph C. Chernoff of
Caltech/JPL
under contract to
NASA Pasadena Office
(NPO-11560)